Pesticide losses in surface runoff from a clay soil in south east Sweden

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Introduction

The contribution from surface runoff to the total losses of pesticides from agricultural land in Sweden is to a large extent unknown. However, surface runoff does occur, especially during snowmelt and during large storm events if the soil surface structure is disturbed (Boye et al, 2012). Surface runoff is highly dependent on the infiltration capacity of the soil which in turn is influenced by the structure close to the soil surface. ***The objective of this study was to quantify the losses of commonly used pesticides under realistic field conditions and to relate these losses to the temporal variations in near saturated hydraulic conductivity and soil structure***.

Materials and methods

Measurements were conducted on a gently sloping clay loam (32% clay, 33% silt, 35% sand) field near Uppsala in south east Sweden (Fig. 1). We have studied runoff losses of six spring applied pesticides (Table 1) with contrasting properties during 2012 and 2013

Table 1. Pesticide properties taken from the Pesticide Properties Database.

Name	Usage	K_{oc} (ml g^{-1})	Degradation half-life (d^{-1})
Diflufenican	Herbicide	1996*	180
Fluroxypyr	Herbicide	68*	13.1
MCPA	Herbicide	74*	24
Clopyralid	Herbicide	5	34
Pirimicarb	Insecticide	388*	86
Prothioconazole	Fungicide	2556*	0.5

* Calculated from Freundlich adsorption constant.

Figure 1. The field site. Surface runoff was collected from wheel tracks during the growing season.

The soil hydraulic conductivity close to saturation was measured with tension infiltrometers on undisturbed soil and in wheel tracks in August 2012 and during the growing season 2013.

Soil columns (10 cm high, 6.8 cm diameter) sampled at the soil surface during the growing season of 2013 were analysed using a *GE Phoenix v|tome|x m* industrial X-ray scanner. The soil macroporosity was calculated from 3D-reconstructions (voxel size 60 µm) of the soil using the ImageJ software.

References

Boye, K., Jarvis, N., Moeys, J. Gönczi, M., Kreuger, J (2012). Pesticide run-off to Swedish surface waters and appropriate mitigation strategies – a review of the knowledge focussing on vegetated buffer strips. CKB report 2012:1. Centre for chemical pesticides, Swedish university of agricultural sciences, Uppsala, Sweden.

Results

Pesticide concentrations in surface runoff from two events following spring pesticide application in 2012 and three events during snowmelt in 2013 are presented in Fig. 2. The summer of 2013 was dry and no surface runoff was generated.

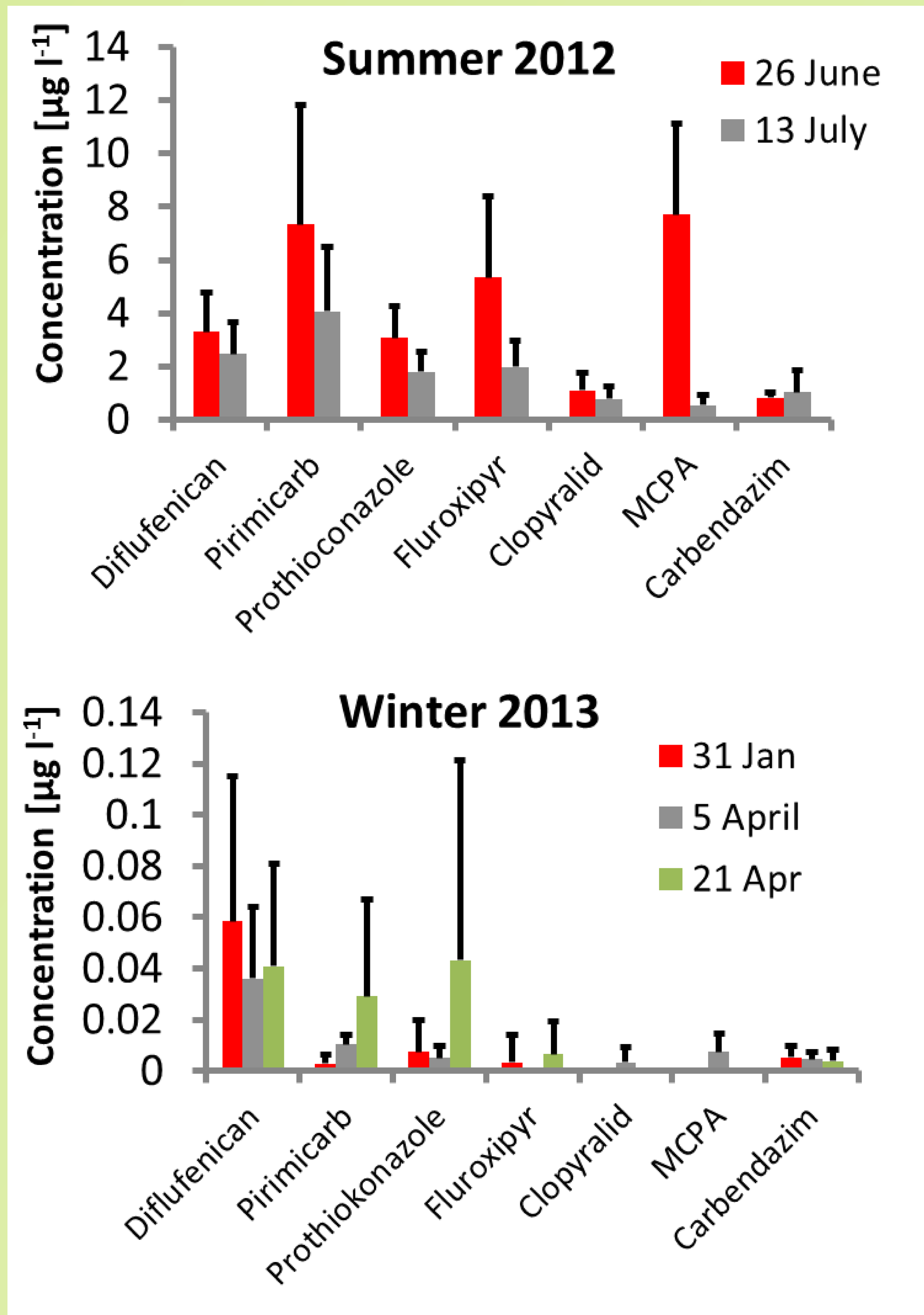

Figure 2. Concentrations of spring applied pesticides in surface runoff. Error bars indicate 1 standard deviation.

A surface crust developed due to rain drop impact during the growing season. In 2013 this crust was destroyed at pesticide spraying resulting in higher hydraulic conductivities in wheel tracks (Fig. 3 and 4).

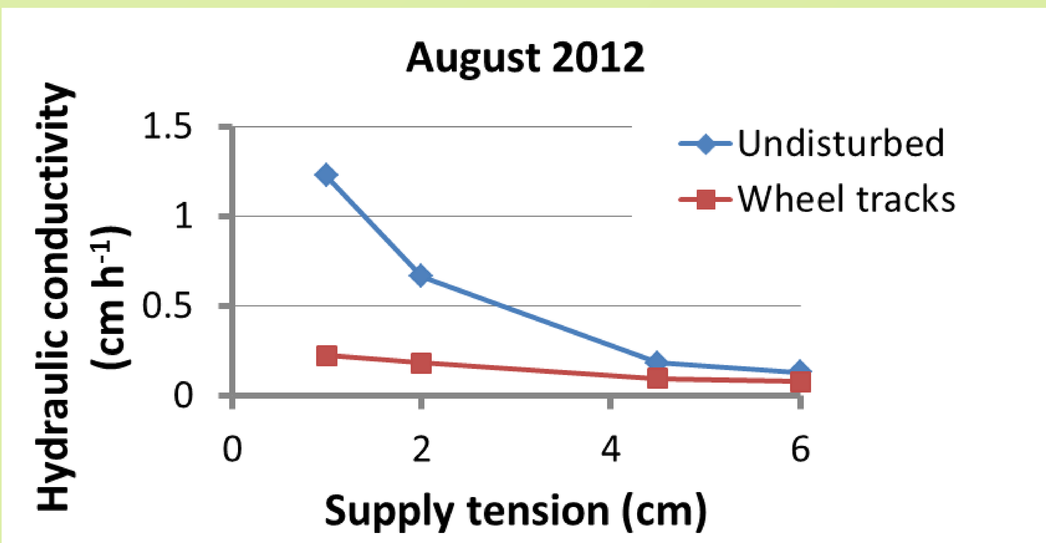

Figure 3. Unsaturated hydraulic conductivity in August 2012. Mean values were significantly different at 1 and 2 cm tensions.

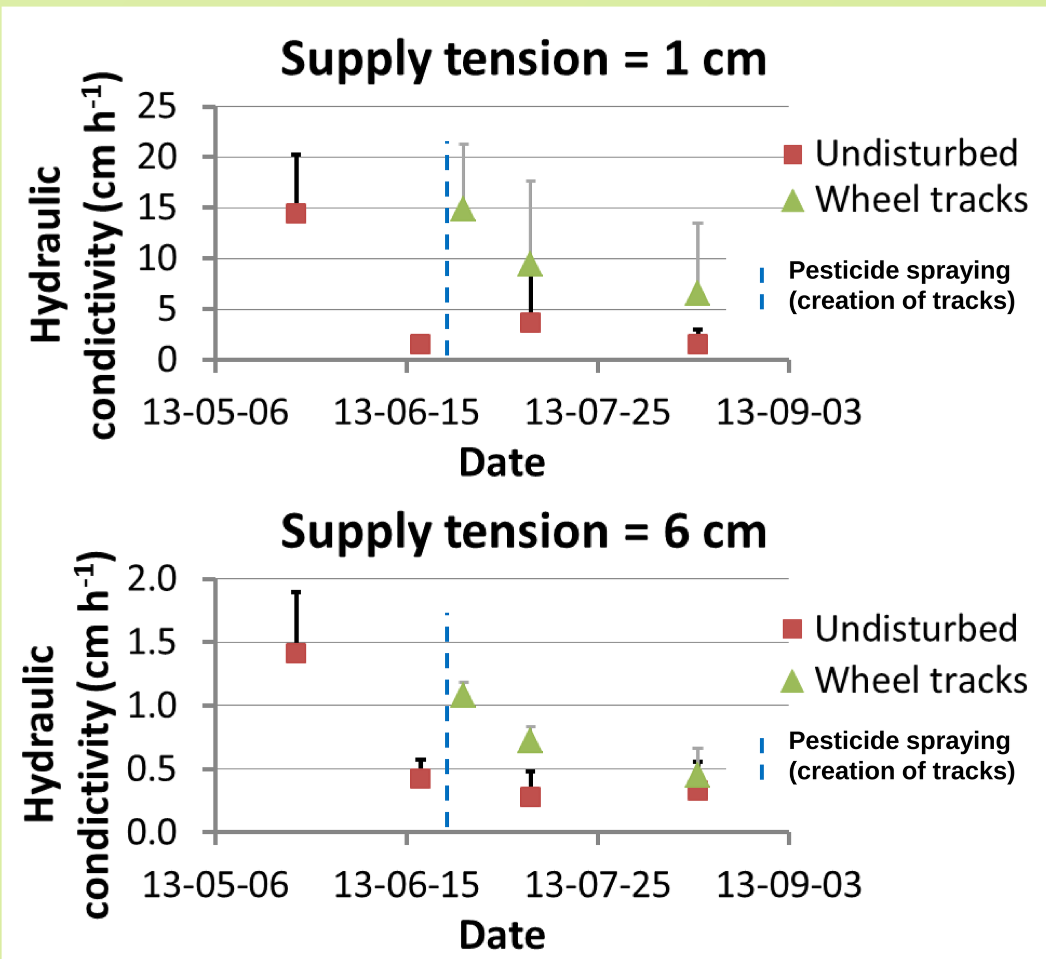

Figure 4. Unsaturated hydraulic conductivity during the growing season 2013. Error bars indicate 1 standard deviation.

Despite large variation in soil structure between replicate samples preliminary results indicate that the macroporosity in the harrowed layer decreased during the growing season 2013 (Fig. 5 and 6).

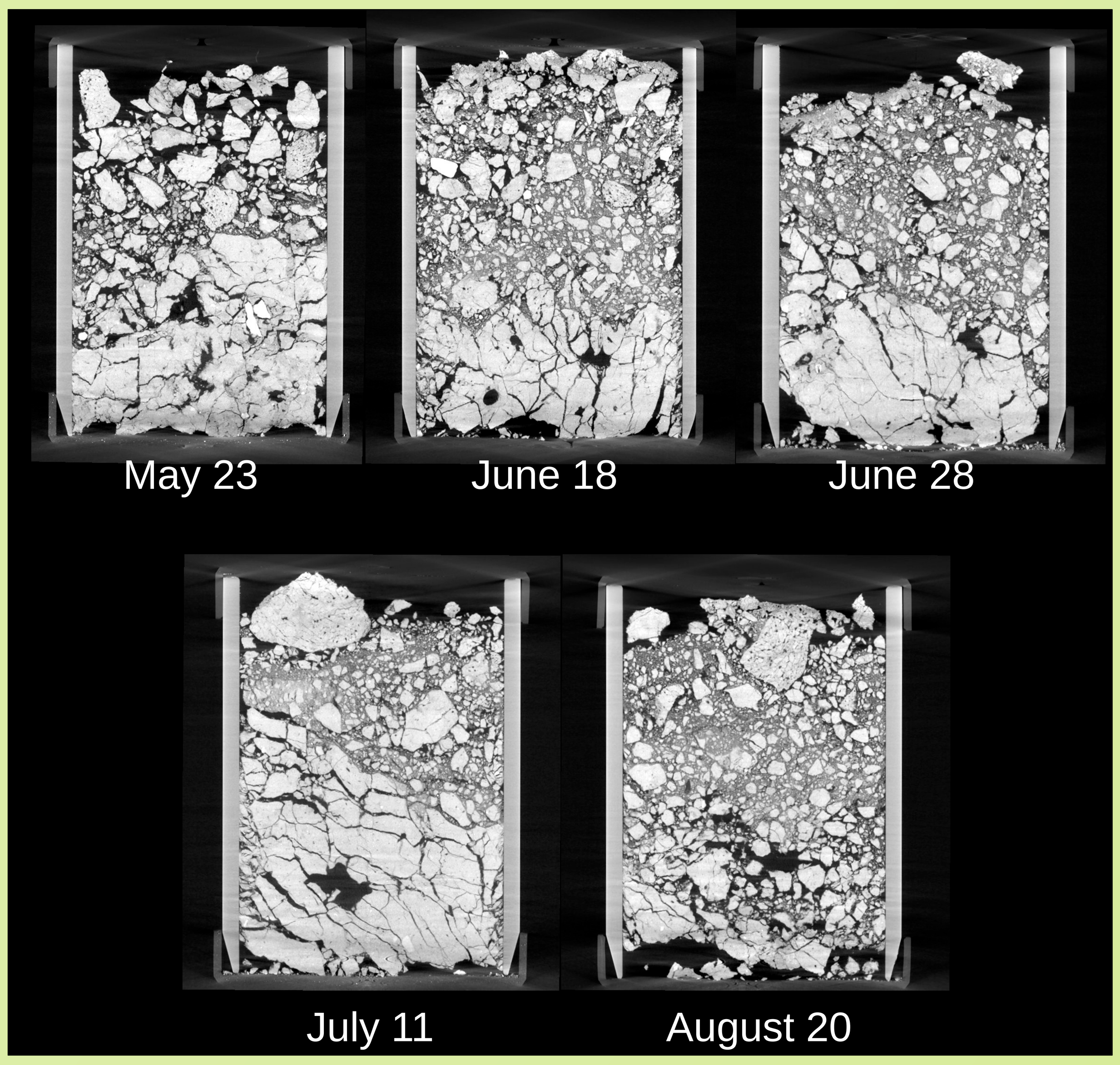

Figure 5. Examples of images reconstructed from X-ray tomography of 10-cm high undisturbed soil columns sampled during the growing season 2013.

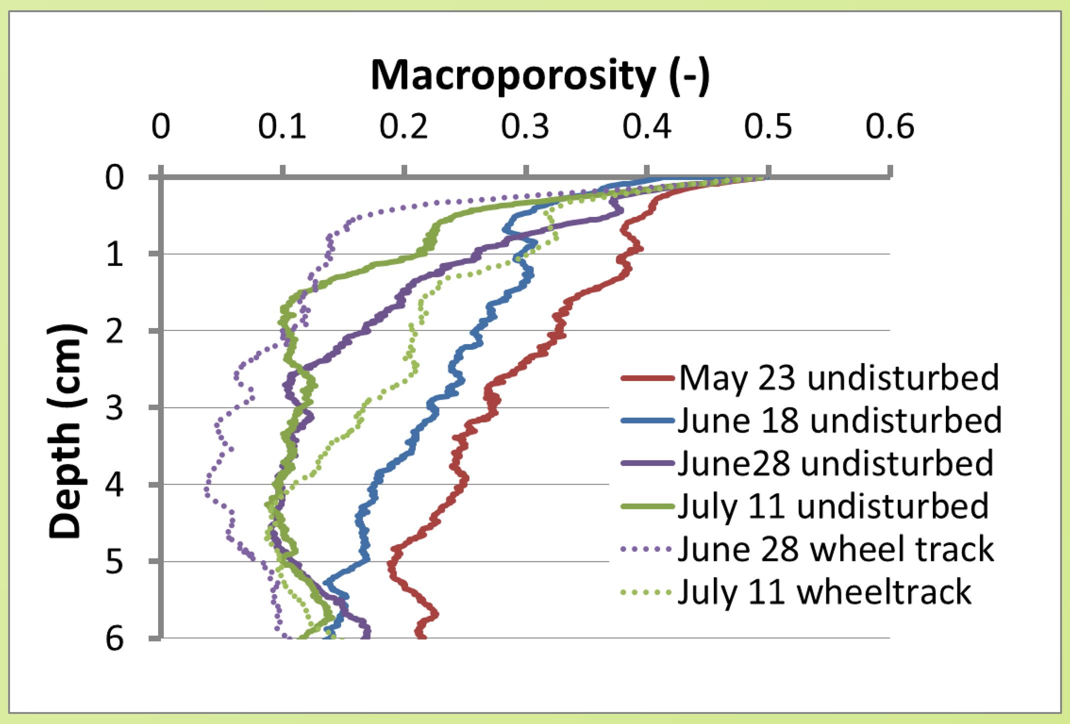

Figure 6. Macroporosity determined from X-ray tomography of 10-cm high undisturbed soil columns sampled from undisturbed soil and in wheel tracks during the growing season 2013.

Conclusions

- **Surface runoff only occurred when the soil was compacted or frozen**
- **Concentrations of pesticides in surface runoff in wheel tracks were high (up to 10 µg l^{-1}) in events following spring application**
- **The hydraulic conductivity close to saturation decreased during the growing season both in undisturbed soil and in wheel tracks**
- **The macroporosity in the harrowed layer decreased during the growing season**
- **The soil surface properties exert a strong control on the infiltration capacity for this clay loam soil when unfrozen**

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